

12. OUTLIER IDENTIFICATION AND RESOLUTION

12.1 INTRODUCTION¹

The purpose of this chapter is to define the term outliers, how they should be identified and documented, and how they may be resolved. An outlier is an item of equipment that does not comply with all of the screening guidelines provided in the DOE Seismic Evaluation Procedure. The screening guidelines are intended to be used as a generic basis for evaluating the seismic adequacy of equipment at DOE facilities. If an item of equipment fails to pass these generic screens, it may still be shown to be adequate for seismic loading by additional evaluations.

This chapter describes how outliers should be identified and documented for equipment that does not pass the screening guidelines for:

- Electrical Equipment (Sections 8.1)
- Mechanical Equipment (Sections 8.2 and 10.2)
- Tanks (Sections 9.1 and 10.3)
- Piping, Raceway, and Duct Systems (Sections 9.2, 10.1, and 10.4)
- Architectural Features and Components (Section 10.5)
- Relays (Chapter 11)

Several generic methods for resolving outliers are summarized in this chapter. Specific methods for addressing the different types of equipment are also discussed in the sections where the screening guidelines are described.

The chapter is organized as follows:

- A summary of generic methods for resolving outliers is contained in Section 12.2.
- Suggested methods for grouping and pooling of outliers from several different facilities for efficient reconciliation are provided in Section 12.3.
- The reasons for classifying an item of equipment as an outlier are described in Section 13.3 along with a description of how outliers should be documented.

12.2 OUTLIER RESOLUTION²

Several generic methods for resolving outliers are summarized below. Additional specific methods for addressing outliers for the different types of equipment are also discussed in the sections where the screening guidelines are described. The details for resolving outliers, however, are beyond the scope of this procedure. It is the responsibility of the facility to resolve outliers using their existing engineering procedures as they would resolve any other seismic concern.

It is permissible to resolve outliers by performing additional evaluations and applying engineering judgment to address those areas which do not meet the screening guidelines contained in this

¹ Based on Section 5.0 of SQUG GIP (Ref. 1)

² Based on Section 5.3 of SQUG GIP (Ref. 1)

procedure. Strict adherence to the screening guidelines in the DOE Seismic Evaluation Procedure is not absolutely required; however, these additional outlier evaluations and the application of engineering judgment should be based on a thorough understanding of the screening guidelines contained in the DOE Seismic Evaluation Procedure and the background and philosophy used to develop these guidelines as given in the applicable references. The justification and reasoning for considering an outlier to be acceptable should be based on mechanistic principles and sound engineering judgment.

The screening guidelines have been thoroughly reviewed by experts to ensure that they are acceptable for generic use in DOE facilities; however, the resolution of outliers for individual facilities will not likely receive the same level of review as the generic screening guidelines. Therefore, it is recommended that the evaluations and judgments used to resolve outliers be thoroughly documented so that independent reviews can be performed if necessary as discussed in Section 2.2.

Some of the methods summarized below for resolving outliers build upon the earthquake experience and generic testing data discussed in the DOE Seismic Evaluation Procedure. Facility personnel may use the Screening Evaluation and Walkdown procedure described in Section 2.1.3 in applying earthquake experience or generic testing data which was not available during the initial walkdown for resolution of outliers or they may develop an alternative approach which best fits the circumstances of the specific outlier issue. Outlier issues may also be resolved using current procedures and criteria. As an alternative, facility personnel may choose to not perform corrective modifications or replacement of outliers. Instead, facility personnel must then explain to the DOE the safety implications of not modifying or replacing the outliers.

Methods which can be used to resolve outliers include the following:

1. The subject equipment and/or its anchorage may be fixed or modified to bring it within the scope of the DOE Seismic Evaluation Procedure or in compliance with some other seismic qualification method. For example, appropriate anchorage should be installed for equipment lacking adequate anchorage.
2. The subject equipment and/or its anchorage may be evaluated more rigorously to determine appropriate techniques for strengthening it in order to bring it within the scope of the DOE Seismic Evaluation Procedure or in compliance with some other seismic qualification method. For example, the equipment or its supports may be stiffened so that its resonant frequency is increased to a frequency where the seismic demand is less. Providing an upper lateral support to a floor-mounted item of equipment would typically increase the fundamental frequency to above 8 Hz.
3. The subject equipment may be replaced with equipment which is covered by screening guidelines in the DOE Seismic Evaluation Procedure or has been seismically qualified by some other means.
4. Detailed engineering analyses may be performed to more carefully and/or accurately evaluate the seismic capacity of the equipment and/or the seismic demand to which it is exposed. For example, when using more accurate analytical procedures, consideration should be given to using "as-built" rather than specified minimum material properties for the equipment.
5. The earthquake experience equipment class may be expanded to include the equipment or specific equipment features of interest. The scope of the earthquake experience data which is documented in References 19 and 35 represents only a portion of the total data available.

An expansion of the earthquake experience equipment classes beyond the scope included in Chapters 8, 9, 10, and 11 could include a more detailed breakdown by type, model or manufacturer of a particular class of equipment, less restrictive requirements for inclusion within a class, or development of a sub-category with higher capacity.

Extension of the generic experience equipment classes beyond the descriptions in the DOE Seismic Evaluation Procedure is subject to DOE review and to an extensive peer review beyond what is discussed in Section 2.2. The external peer review for expanding the earthquake experience database should be of similar caliber as that required during the original development of the database. An extension of the earthquake experience database must satisfy the requirements discussed in Section 1.4.4.

6. In-situ tests may be performed on the equipment of interest to determine more accurately the equipment dynamic properties.
7. Shake table tests may be performed on the same or similar equipment to check its seismic capacity or evaluate more carefully its dynamic properties.
8. Information not available during the Screening Evaluation and Walkdown may be obtained and used to meet the DOE Seismic Evaluation Procedure screening guidelines.

The most appropriate type of outlier evaluation will depend upon a number of factors, including the reason that the equipment failed the screening guidelines, whether the outlier lends itself to additional review of the earthquake experience or generic testing data or an additional analytical evaluation, the cost of design or hardware modifications, and how extensive the problem is in the facility and in other facilities. Any type of outlier evaluation will require peer review as discussed in Section 2.2. The DOE should be provided with a proposed schedule for complete resolution or future modifications and replacement of outliers. Documentation of the methods used by the facility for resolution of outlier issues and tracking of their implementation can be provided in the OSES as discussed in Section 13.3.

12.3 GROUPING AND POOLING OF OUTLIERS³

Once an outlier has been identified and an OSES is prepared for that item of equipment, the OSES could then be placed in an appropriate outlier category or "basket". There could be one basket for each class of equipment for which there are outliers. Within each basket the outliers could be further divided into the various reasons that the equipment failed the screening evaluation (e.g., capacity vs. demand, caveats, anchorage, or interactions). The organization of the outliers in this manner can facilitate reconciliation of recurring outlier issues.

One method to efficiently reconcile recurring outliers in DOE facilities is for them to pool the outlier information obtained during walkdowns. One means of pooling this information is to tabulate the outliers, including the information contained on the SEDS and, if available, the method ultimately used to evaluate the seismic adequacy of the outlier. These tables may be generated and organized, using a data base management program. This summary may be distributed to DOE facilities so that common outliers may be evaluated using the experience obtained from other facilities. For example, one facility may have one or several unreconciled outliers that an SRT at another facility was able to evaluate. The facility with the unreconciled outliers may be able to employ a similar methodology if the detailed information used in the outlier resolution is shared. Outliers from several DOE facilities may also be resolved more cost-effectively using shared funding.

³ Based on Section 5.4 of SQUG GIP (Ref. 1)